FLUORESCENT LIGHTING

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The fluorescent light is unique and important—unique in that it has no filament; important since it has brought new possibilities to almost all fields of applied lighting.

Operating Principle

Contrary to popular opinion, the principle behind the operation of the fluorescent lamp is not new; as a matter of fact it has been known to science for hundreds of years, just as the principle of the incandescent lamp was known for many years before the invention of a practical lamp of this type. Unlike incandescence, which refers to the production of light by means of heating a material to an extremely high temperature, fluorescence deals with the conversion of invisible radiant energy into visible light of a longer wave length. In the fluorescent lamp, which might be described as a thin tube of glass in varying lengths and diameters, the invisible ultra-violet energy produced by an electric glow discharge between two electrodes in a rarefied atmosphere of argon gas and mercury vapor is converted into visible light through the action of the fluorescent material or phosphors coating the inside surface of the lamp.

Auxiliary Equipment

Fluorescent lamps in common with all electric discharge sources, such as neon, mercury and sodium vapor, require the use of auxiliary control equipment. This auxiliary equipment consists of a current limiting device or ballast and a starting switch. The fluorescent ballast is no more than a coil of wire wound on an iron core in such proportions as to limit the current to the proper value for a particular size of lamp. The starting switch has a dual purpose, first, to act as a time delay switch which momentarily connects the two electrodes in series with the ballast during a short preheating period after the lamp has first been turned on, and then to open the circuit so that the arc may be established. The preheating operation causes a great emission of electrons and makes it possible to strike the arc with a comparatively low voltage, whereas the cold cathode type of sign tubing requires a high voltage. The establishment of the arc is given additional impetus by the inductive kick or voltage surge produced by the ballast when the starting switch opens.

Power Factor

A choke coil, such as the fluorescent ballast in an electrical circuit, because of its inductive effects introduces a power factor, that is, a differential in phase relation between voltage and current. The power factor of the first fluorescent lamps was no more than 60 per cent. This comparatively low power factor meant that the current in the wires used to supply the lamps was much greater than the wattage would indicate.

Power factor correction is important to public utilities in regard to rate fixation and equally important to the user in terms of wiring capacity. For these reasons a great amount of study and experimentation has taken place in connection with power factor correction. The outstanding result of this experimentation has been the development of the two-lamp ballast.

The two-lamp ballast includes two separate choke coils and uses the "split-phase" principle for power factor correction. Under this method one lamp is ballasted by a choke coil only and the other by a choke coil and condenser in series. Correction by this method is possible since a condenser produces what is known as a "leading" power factor which offsets the lagging power factor of the inductive choke coil and results in an overall power factor of 95 per cent or better.

In certain installations where a two-lamp ballast cannot be used or where it is desired to correct the power factor of an existing installation employing single lamp ballast, separate condensers may be used in the circuit. A variety of condensers are available for correcting the power factor of single lamps or of several lamps. Power factor correction at each individual reflector is most desirable and the two-lamp ballast is the ideal method of correction since it also eliminates the stroboscopic effect objectionable in certain cases.

Stroboscopic Effect

Fluorescent lights, like neon lights, when operating on an alternating circuit, have a tendency to cease giving off light when the current is zero. While this variation or flickering is too rapid to be noticed by the eye, certain conditions make plainly visible a stroboscopic effect. Moving parts of machinery by this light may appear to jerk and jump while rotating parts may seem to be rotating more slowly than their actual speed or possibly appear to be traveling in the reverse direction. In the case of fluorescent lamps the fluorescent powder coating the inside of the tube has a persistence of glow which tends to counteract this flicker. The two-lamp ballast is often used to reduce the flicker as the light from one lamp is at a maximum while that of the other is at a minimum. Stroboscopic effect and power factor no longer cause concern in considering applications of this new light source, for both are, to a large extent, eliminated by the use of the two-lamp control circuit.

Colors

The wavelength or color of the light produced in the fluorescent lamp is directly dependent upon the kind of phosphors used in coating the inside of the lamp. At the present time fluorescent bulbs are available in five colors and four different types of white. The colors are red, pink, gold, green and blue. All of the lamps appear white when they are not lighted except the red and gold. The red and gold lamps are coated with colored pigment before the phosphors are applied, and therefore show their color even though they are not lighted. The pigments are added so that truer color values may be obtained. Some of the phosphors used are: calcium tungstate in the blue bulb, calcium borate in the pink, and zinc silicate in the green. The popular daylight fluorescent bulb is an almost exact equivalent of light from an overcast sky and is obtained by mixing the pink, blue and green phosphors in various proportions.

Efficiency

The high efficiency of fluorescent lamps has attracted much attention. It is only natural that the efficiency of this new light source should be compared with that of the familiar incandescent lamp. In order that no misunderstanding will result, the comparison of these two light sources will be made on the basis of light output in lumens and light input in watts. The lumen is a unit for measuring the total quantity of light from a given source. By way of a concrete example, a 48 inch white fluorescent lamp produces 2100 lumens. The lamp consumes 40 watts plus the losses in the auxiliary equipment which are rarely over 10 watts. Therefore 50 watts can be taken as a liberal figure for the entire wattage consumed by the 40 watt lamp and its auxiliary. Dividing 2100 by 50 gives the result of 42 lumens for each watt consumed. A standard 50 watt incandescent lamp has an efficiency of 13.2 lumens per watt. The fluorescent lamp is, in this cases, 42/13.2 or 3.2 times as efficient.

The comparison of a colored fluorescent lamp with the extremely inefficient color filter and incandescent lamp combination clearly points out the advantage of using fluorescent color lamps in those cases where

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Fluorescent Lighting in Practice Courtesy of Gen. Elect.

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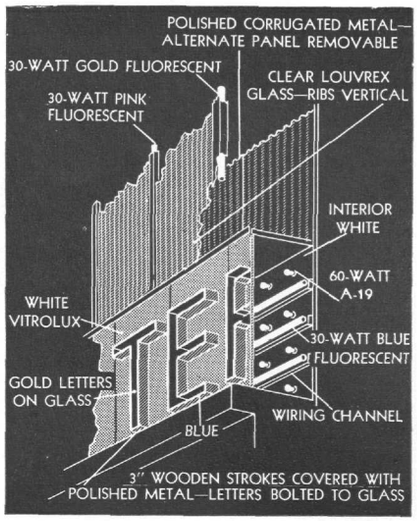
color is desired. A filter in combination with an incandescent bulb filters out a very high percentage of the light that the bulb puts out in order that the single desired color is obtained. The fluorescent lamp works on an entirely different principle; it converts the invisible radiant energy into visible light of the desired color and only the desired color. In other words, the fluorescent lamp produces colored light directly and not by means of a filter. The direct production system of the fluorescent lamp is obviously much more efficient than the indirect incandescent lamp and filter method in the production of colored light—in many cases up to 200 times as efficient.

Fluorescent lamps have a life which is limited only by the darkening of the ends of the tube caused by the material given off by the electrodes along with interaction of phosphor and mercury, and the dissipation of argon gas, which prevents starting. This life may vary from two thousand to ten thousand hours while incandescent lamps are rated at one thousand hours. An important fact regarding the life of fluorescent lamps is that they lose their usefulness because of lumen depreciation before they cease to give off light; the lamps should be discarded when they fail to give off sufficient light. Frequent starting of the lamps shortens their useful life because the momentarily higher than normal voltage drop at the electrodes causes the active material to dissolve off.



Installation of Fluorescent Lights

Courtesy Gen. Elect.

Applications and Cost Considerations

Fluorescent lighting was used extensively in both the external and internal lighting of buildings at the New York World's Fair and the San Francisco Exposition. These massive installations paved the way for this new light source and opened the eyes of architects and engineers. A significant advantage of fluorescent lamps is the precise and efficient manner in which they pro-

A Striking Example of Fluorescent Lighting

Courtesy Gen. Elect.

duce daylight color. The daylight lamp has gained popularity in the lighting of display rooms, sample rooms and factories, where close adjustment of color is necessary.

The low surface brilliance of fluorescent lamps has proved an important point as far as the moving picture industry is concerned. This industry uses large banks of these lights in much of their photographic work for they have found that this type of light may be brought up to an actor's face without danger of the actor squinting.

Under identical conditions a fluorescent lamp will yield only about one quarter as much heat as is emitted from an incandescent bulb of equivalent lumen output. This coolness makes them especially desirable for use in refrigerated cases, where meat, vegetables and other perishables are displayed.

Wherever abundant color makes for better display or attraction, fluorescent lighting can be found—in hotels, in stores, in shops, in theatres and in industry. On showcases and desks, in lounges and lobbies, in restaurants and in trains, at home or at work—this new light is everywhere.

Yet it must be remembered that fluorescent lighting is still in its infancy, and, although it has a great many advantages, it also has disadvantages. Nevertheless, it is a big thing in the field of illumination—just how big no one knows. Only time can tell.